

A journey through Coastal Moonah Woodland in Victoria

Claire Moxham* and Vivienne Turner

The Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment,
123 Brown Street (P.O. Box 137), Heidelberg, Victoria 3084, Australia.

*Corresponding author. Email: Claire.Moxham@dse.vic.gov.au

Abstract

This descriptive study depicts a journey through the distribution and variation of the threatened plant community Coastal Moonah Woodland in Victoria. Extant remnants are distributed in three broad geographic regions. In the south-west, stands are scattered from the South Australian border through to Portland, with one small isolated remnant at Warrnambool. On the Surf Coast, remnants are scattered from Aireys Inlet through to Queenscliff on the Bellarine Peninsula. Remnants occur on the southern Mornington Peninsula, with adjunct stands on Phillip Island and Wilsons Promontory. The community varies in species composition, abundance and vegetation structure in relation to landscape position, exposure to coastal influences and disturbance history. The condition of remnants is generally poor due to their small size and coastal location where disturbance due to human activity and weed invasion is often high. The more isolated remnants in the south-west of the state appear to be better quality. This variety in vegetation structure and condition provides a diverse foundation for future enhancement of degraded Coastal Moonah Woodland remnants that may increase the success of conservation efforts. (*The Victorian Naturalist* 126 (5) 2009, 170–179)

Key words: *Melaleuca lanceolata*, calcareous dunes, floristic composition, statewide distribution

Introduction

The plant community Coastal Moonah Woodland occurs on alkaline dune systems within 10 km of the Victorian coast and is listed as threatened under the Victorian *Flora and Fauna Guarantee Act* 1988. Coastal Moonah Woodland occurs within the broader vegetation classification Ecological Vegetation Class (EVC) Coastal Alkaline Scrub (DSE 2004). Coastal Alkaline Scrub occurs on coastal, deep calcareous sand deposits, dune limestone, alkaline sand dunes and swales, which date from the Pleistocene (Bird 1975; McGregor and Johnstone 1987; Oates and Taranto 2001). Within this EVC, Coastal Moonah Woodland usually occurs on coastal limestone deposits, forming calcareous dunes, and previously occupied large areas of coastal limestone in Victoria (Calder 1975; JCVRFASC 2000). The Scientific Advisory Committee (SAC) (1998) considered the community to have a restricted distribution in southern Victoria due to this dependence on alkaline soils and coastal influences (SAC 1998). However, what appears to be this community has also been identified on peaty and clay soils in other locations (Sutter and Downe 2000; this study).

Coastal Alkaline Scrub and Coastal Moonah Woodland remnants are known to occur in three broadly defined geographic regions along coastal Victoria. Stands occur in the south-

west (SW) from the South Australian border through to Portland. Remnants are scattered along the Surf Coast from Aireys Inlet to the Bellarine Peninsula (BP/SC) and on the southern Mornington Peninsula (MP), with adjunct stands occurring on Phillip Island and Wilsons Promontory. There is a lack of knowledge regarding the pre-European distribution of this community and thus the significance of remaining stands. For example, on the Mornington Peninsula, Coastal Moonah Woodland is thought to have covered some 12 500 ha prior to European settlement (DSE 2002). Currently the extent of the community is less than 1000 ha (about 10% of its original extent) most of which is significantly degraded (Tonkinson *et al.* 2003). Consequently the community is listed as threatened under the *Flora and Fauna Guarantee Act* 1988 because it is in a demonstrable state of decline, which is likely to result in extinction (SAC 1998; DSE 2002).

The Action Statement (DSE 2002) prepared under the *Flora and Fauna Guarantee Act* 1988 provides the main floristic description of Coastal Moonah Woodland for Victoria, and considered the following plant species (nomenclature according to Walsh and Stajsic 2007) to be characteristic of the community: Coast Wirlida *Acacia uncifolia*, Rare Bitter-bush *Adriana quadripartita*, Small-leaved Clematis *Clematis*

microphylla, Kidney-weed *Dichondra repens*, Coast Tea-tree *Leptospermum laevigatum*, Coast Beard-heath *Leucopogon parviflorus*, Moonah *Melaleuca lanceolata* subsp. *lanceolata*, Thyme Rice-flower *Pimelea serpyllifolia* subsp. *serpyllifolia* and Coast Swainson-pea *Swainsona lesertiifolia* (SAC 1998; DSE 2002). Although the name of the community suggests that Moonah is the dominant canopy component of the community, this is misleading, as Coast Wirilda, Coast Tea-tree and Coast Beard-heath can also be co-dominant or even dominant in some instances. The community name suggests that structurally it is woodland. However, the community generally forms a low open-forest (following the structural classification of Specht and Specht 1999). This structural classification is variable as it also may be considered an open or closed shrubland, woodland, open woodland and open-forest (DSE 2002) depending on its location in the landscape and exposure to coastal influences. The information used to define the Action Statement community description was based mainly on data from the Mornington Peninsula.

Aims

Working within the confines of the Scientific Advisory Committee (1998) nomination of Coastal Moonah Woodland and the Action Statement (DSE 2002), remnants occurring on calcareous dunes throughout coastal Victoria were investigated to gain further insight into the nature of the plant community, Coastal Moonah Woodland, through documenting the distribution (pre-European (1750) and current) and floristic variation of this plant community. This information should assist land managers in the identification and management of Coastal Moonah Woodland.

Survey methods

GIS (geographical information system) vegetation mapping was undertaken to determine possible locations of remnants of Coastal Moonah Woodland in Victoria. The majority of remnants were then ground truthed and a selection of sites was chosen randomly for detailed vegetation sampling. Vegetation quadrats were also extracted from the Victorian Flora Information System database (FIS 2007). Due to differences in these data sets not all quadrat data were used in all analyses. It should be noted that this descriptive study is a collation

of information obtained from various Coastal Moonah Woodland projects the authors have undertaken since 2002.

Vegetation mapping

GIS data held by the Department of Sustainability and Environment including hydrology, topography, geology, extant and pre-1750 EVC layers and aerial photographs were used (Arcview 3.2) to determine known and possible locations of Coastal Alkaline Scrub, and hence possible stands of Coastal Moonah Woodland. Probable remnants were ground truthed in the field and then digitised to form the current distribution of Coastal Moonah Woodland. The likely pre-European distribution of Coastal Moonah Woodland was determined by combining the geology and pre-1750 EVC layers.

Vegetation survey

A total of 89 vegetation quadrats, each 10 x 10 m, were undertaken in spring over a four-year period from 2002 to 2006 in known Coastal Moonah Woodland remnants. In each quadrat the following information was recorded: GPS location (GDA 94, zone 54), aspect, altitude, height (metres) of dominant canopy species, and canopy cover, the length of logs > 100 mm diameter, and of branches < 100 mm diameter. Projective foliage cover values were estimated for mid-storey trees, shrubs, perennial grasses, perennial forbs, weeds, litter, bare ground and moss. All vascular plant species were identified and their percentage foliage cover recorded using a modified example of the Braun-Blanquet scale based on Ough (2001). Plant taxonomy follows Walsh and Stajsic (2007) and structural types were determined according to the system of Specht and Specht (1999). A further 71 vegetation quadrats were extracted from the Victorian Flora Information System (FIS 2007), thus a total of 160 vegetation quadrats were used for analysis (Table 1). Vegetation quadrats extracted from the FIS did not include environmental attributes such as litter, bare ground and moss, thus data presented in relation to these groupings is a subset.

Survey outcomes

Community state-wide comparisons

It is estimated that Coastal Moonah Woodland once occupied some 12978 ha of coastal lime stone in Victoria before European settlement (Fig. 1). Coastal Moonah Woodland currently

Table 1. Summary locations of stands of Coastal Moonah Woodland in coastal Victoria, displaying the broad geographic region, data source, general location, number of quadrats undertaken and whether the remnant was ground truthed in this study.

Source	General location	No of quadrats	Ground truthed
South-western		11	
This study	Bridgewater Lakes	3	Y
FIS	Bridgewater Lakes	2	Y
This study	Discovery Bay	4	Y
FIS	Nelson	2	Y
This study	Nelson		Y
This study	Portland		Y
This study	Warrnambool		Y
Bellarine Peninsula/Surf Coast		31	
This study	Bells Beach		Y
This study	Anglesea		Y
This study	Torquay		Y
FIS	Anglesea	3	Y
FIS	Aireys Inlet	1	Y
FIS	Breamlea	7	Y
FIS	Pt Addis	2	Y
FIS	Jan Juc	1	Y
This study	Barwon Heads	2	Y
This study	Pt Ionsdale	3	Y
This study	Queenscliff		Y
This study	Swan Island		Y
FIS	Barwon Heads	5	Y
FIS	Queenscliff	2	Y
FIS	Swan Island	5	Y
Mornington/Nepean Peninsula		118	
This study	Nepean Peninsula	77	Y
FIS	Nepean Peninsula	30	Y
This study	Churchill Island		Y
FIS	Churchill Island	3	Y
This study	Phillip Island		Y
FIS	Phillip Island	6	Y
FIS	Wilsons Promontory	2	N
Total		160	

occupies 980 ha, around 7.5% of its original distribution. In the south-west of the State it occupies less than 3.5% of its original distribution (pre-1750 – 5200 ha, currently – 180 ha) occurring from Portland through to the South Australian border. Only one very isolated stand remains in the Warrnambool area. Along the central southern coast only 9% remains (pre-1750 – 7778 ha, currently – 800 ha), where on the Surf Coast scattered stands occur from Aireys Inlet through to Queenscliff on the Bellarine Peninsula and on the Mornington Peninsula, mainly on the Nepean Peninsula, with outliers on Phillip Island and Wilsons Promontory.

Throughout Victoria, remnants of Coastal Moonah Woodland had an average of 26 vascular plant species per quadrat (Fig. 2, range 6 – 44). The south-west remnants had the highest richness, with 31 species (range 15 – 43) and there was a predominance of native species. The Bellarine Peninsula/Surf Coast and Mornington Peninsula remnants had similar species richness, 24 (range 6 – 43) to 26 (range 6 – 44) respectively, as well as comparable native to exotic species ratio. Of the 444 plant species recorded in this community throughout the State, 256 (58%) were native.

Throughout the State, Moonah is notably the most frequent species, followed by Coast Beard-heath and Coast Tea-tree (Table 2). These species are common in the canopy, while Coast Beard-heath and Coast Tea-tree also frequently inhabit the shrub stratum.

The most commonly occurring exotic species in Coastal Moonah Woodland remnants is Hare's Tail *Lagurus ovatus*; this species occurred in greater than 50% of quadrats (Table 2). Other exotic species that frequently occurred at sites, but have not been reported before as common in this community, include Common Sow-thistle *Sonchus oleraceus*, and the following grasses, Fern Grass *Catapodium rigidum*, Fescue *Vulpia* spp. and Hair Grass *Aira* spp.

When comparing the broad life-form groups, moss, bare ground and litter values for Coastal Moonah Woodland from the geographical regions, the more remote remnants in the south-west have a higher cover of moss and canopy (Fig. 3). In contrast, remnants in the Bellarine Peninsula/Surf Coast and Mornington Peninsula regions have a lower cover of these life forms and a higher cover of litter, bare ground, perennial grasses, weeds, shrubs and mid-storey shrubs (Fig. 3).

A common finding across the state was that herbs comprised about 75% of the cover in Coastal Moonah Woodland communities. Grasses and sedges represented 25% of this group (Fig. 4). The south-western remnants differed from the rest of the State with a higher proportion of Golden Wattle *Acacia pycnantha*, Coast Wattle *Acacia longifolia* var. *sophorae* and Coast Ballart *Exocarpos syrticola* in the canopy layer (Fig. 5). The south-west remnants also lack Coast Tea-tree and Coast Wirilda, which are common in the south-central remnants.

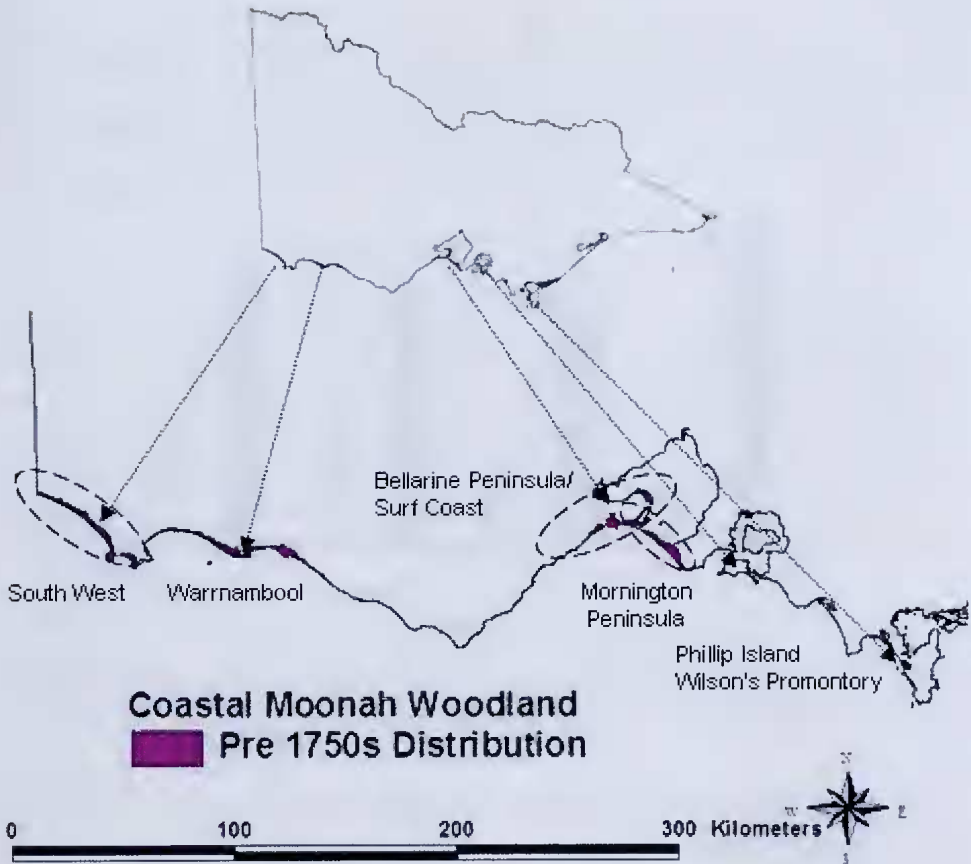


Fig. 1. The probable pre-European (pre-1750) distribution of Coastal Moonah Woodland in Victoria. Hatched ovals highlight the three main regions (South-west, Bellarine Peninsula/Surf Coast and Mornington Peninsula), with outliers on Phillip Island and Wilsons Promontory, where remnants of the plant community can still be found.

Community regional comparisons

South-west

In the south-west of the State, prior to European settlement, Coastal Moonah Woodland probably occupied 5200 ha in a band from the South Australian border along the coast to Cape Bridgewater and Cape Nelson. Situated between Coastal Scrubs and Eucalypt Woodlands, it would have extended inland generally around 2 km but in some locations up to 6 km. Currently Coastal Moonah Woodland occupies 180 ha (approximately 3.5% of its original extent) in south-western Victoria.

In the south-east of South Australia, near the Victorian border, Crocker (1944) described a floristic community where Moonah is the dom-

inant and Drooping Sheoke *Casuarina stricta* (now *Allocasuarina verticillata*) and Sweet Bursaria *Bursaria spinosa* are sub- or co-dominant. In this community grasses and forbs dominated the ground flora. In 1964 the Soil Conservation Authority published *A study of the land in south-western Victoria* where it also describes a Moonah–Drooping Sheoke tall dry scrub in the region (Gibbons and Downes 1964). On the Eyre Peninsula, a Moonah–Drooping Sheoke association is common, with Moonah the usual dominant. Also in south-western Victoria, Head (1988) examined pollen, sediments and charcoal layers as well as peat profiles in the Discovery Bay region. Head (1988) determined that over the past 6000 years *Allocasuarina*

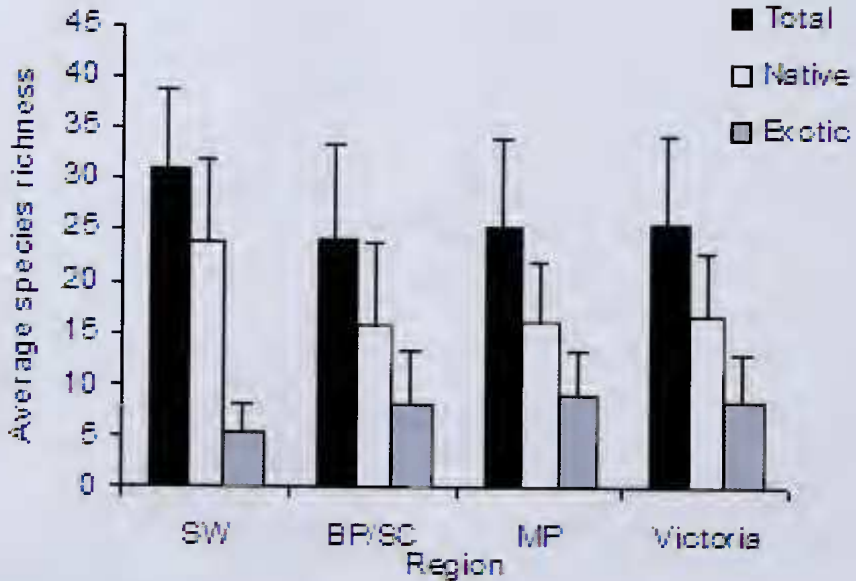


Fig. 2. The average species richness of native, exotic and all species recorded in the floristic quadrats, displayed across the three geographic regions: SW = South-west ($n = 11$), BP/SC = Bellarine Peninsula and Surf Coast ($n = 31$), MP = Mornington Peninsula ($n = 118$) and Victoria as a whole ($n = 160$). The standard deviation is shown.

woodland dominated the dryland vegetation, with a Moonah composite scrub association on the dunes. Grasses dominated the understorey with scattered occurrences of *Bursaria*, Moonah and the occasional eucalypt; *Allocasuarina* pollen samples were more common on the landward side and Moonah on the seaward side of the hind dune landscape. Consequently it seems reasonable to suggest that the *Allocasuarina* dominated community may have replaced the Moonah dune community once the dune system stabilised. For the past 7000 years these major vegetation types have been continuously present in this landscape (Head 1988).

Scattered stands of Coastal Moonah Woodland still remain from Portland along the hind dunes to the South Australian/Victorian border (and across the border). Significant stands of Coastal Moonah Woodland occur at Bridge-water Lakes, with other sites scattered along Discovery Bay to Nelson. Coastal Moonah Woodland also occurs at the Enchanted Forest in the Cape Nelson State Park. Remnants of the community are usually found at the landward extent of the coastal dune system and often ex-

tend along watercourses and swamps on peaty soils. One isolated stand occurs at Warrnambool near Thunder Point, suggesting that the community may have once been more widespread in this region.

In the south-west the community occurs in wetter sites and has abundant moss beds, which are quite different from the remnants on the Bellarine and Mornington Peninsulas. Coast Wirilda is absent, replaced to some extent by Coast Wattle. However, Coast Wattle invasion (as an ecological weed) is frequent and appears in, or adjacent to, Coastal Moonah Woodland on disturbed sites. Coast Sword-sedge *Lepidosperma gladiatum* is common in the understorey and is dominant in wet sites. Bower Spinach *Tetragonia implexicoma* occurs at all locations as a major component in the understorey and sometimes reaches the canopy. Manna Gum *Eucalyptus viminalis* and Large-fruited Yellow-gum *Eucalyptus leucoxylon* subsp. *megalocarpa* occasionally occur as scattered individuals around sites near Nelson (FIS 2007).

Bellarine Peninsula/Surf Coast

Pre-European settlement, Coastal Moonah Woodland would have occurred scattered along the Surf Coast, east of Aireys Inlet to Breamlea. Very likely these patches would have extended approximately one kilometre inland and in some regions dominated the riparian zone close to the sea.

Today, stands of Coastal Moonah Woodland are scattered along the Surf Coast between Anglesea and Torquay. The main stands occur at Anglesea, as an ecotone alongside Estuarine Swamp Scrub at the Anglesea River, at Point Roadknight on the Foreshore Reserve and at Bells Beach. These occurrences are in moderate condition. A few highly degraded stands occur at Breamlea and Torquay, with mature Moonah trees scattered amongst residential developments. These remnants occur on carbonaceous clay, sand and basaltic larva, with some stands occurring on peaty soils.

Pre-European settlement, on the Bellarine Peninsula, Coastal Moonah Woodland would have dominated coastal and near-coastal environments reaching approximately 5 km inland in some areas. Most likely it occurred as a large continuous band, beginning a few kilometres before Barwon Heads, extending to Queens-

Table 2. The percent frequency of (A) native species that occurred in 50% or more of quadrats and (B) nine frequent exotic species that occurred in quadrats sampled in Coastal Moonah Woodland. Where Percent Frequency is the number of quadrats, expressed as a percentage, in which each species was recorded.

Scientific Name	% Frequency
(A) Species occurring in 50% + of quadrats	
<i>Melaleuca lanceolata</i> subsp. <i>lanceolata</i>	77
<i>Leucopogon parviflorus</i>	74
<i>Rhagodia candolleana</i> subsp. <i>candolleana</i>	71
<i>Clematis microphylla</i>	66
<i>Tetragonia implexicoma</i>	66
<i>Leptospermum laevigatum</i>	65
<i>Dichondra repens</i>	63
<i>Austrostipa flavescens</i>	50
<i>Pimelea serpyllifolia</i> subsp. <i>serpyllifolia</i>	50
(B) Frequently occurring exotic species	
<i>Lagurus ovatus</i>	53
<i>Polygala myrtifolia</i> var. <i>myrtifolia</i>	44
<i>Sonchus oleraceus</i>	43
<i>Ehrharta erecta</i> var. <i>erecta</i>	41
<i>Catapodium rigidum</i>	39
<i>Asparagus asparagoides</i>	37
<i>Rhamnus alaternus</i>	28
<i>Vulpia</i> spp.	28
<i>Aira</i> spp.	27

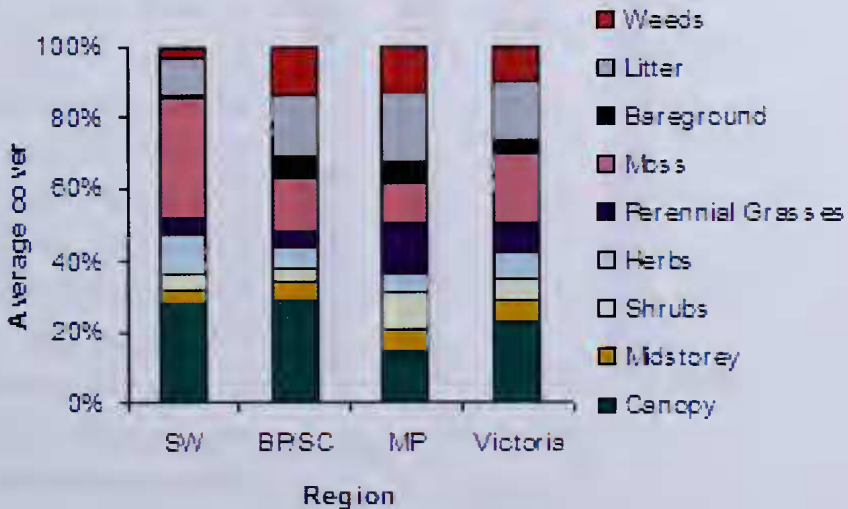


Fig. 3. The average per-cent cover of broad life form groups, moss, bare ground and litter per quadrat expressed as a percentage of the total in the three geographic regions and throughout Victoria. SW = south-west ($n = 7$), BP/SC = Bellarine Peninsula and Surf Coast ($n = 5$), MP = Mornington Peninsula ($n = 77$) and Victoria as a whole ($n = 89$).

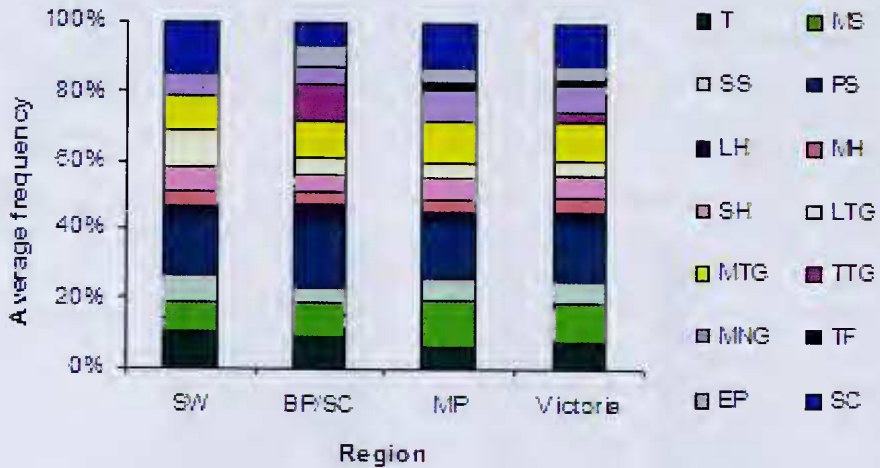


Fig. 4. The average frequency of the different life forms expressed as a percentage of the total, in the three geographic regions and throughout Victoria. SW = south-west (n = 11), BP/SC = Bellarine Peninsula and Surf Coast (n = 31), MP = Mornington Peninsula (n = 118) and Victoria as a whole (n = 160). Life forms are T = tree, MS = medium shrub, SS = small shrub, PS = prostrate shrub, LH = large herb, MH = medium herb, SH = small herb, LTG = large tufted graminoid, MTG = medium tufted graminoid, TTG = tiny tufted graminoid, MNG = medium to tiny non-tufted graminoid, TF = tree fern, EP = epiphyte and SC = scrambler or climber.

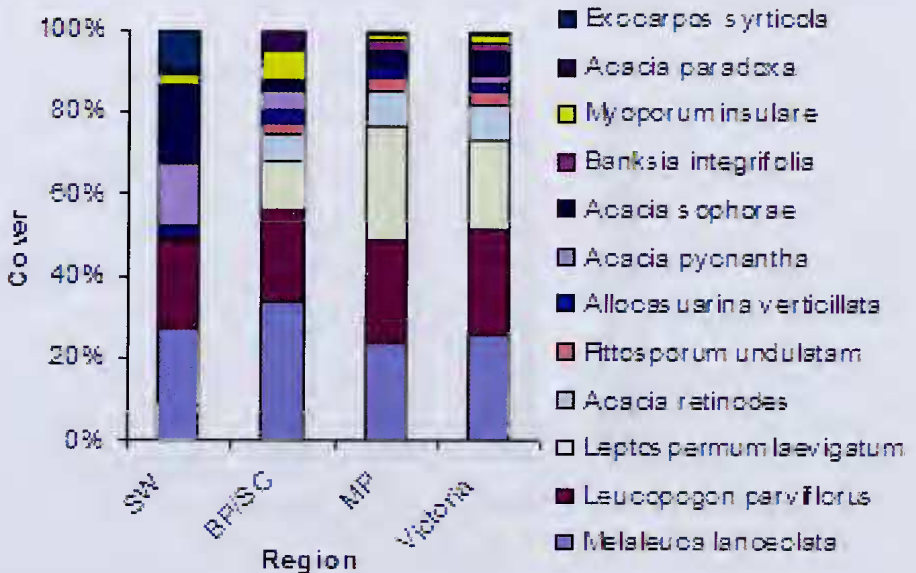


Fig. 5. The average frequency of canopy species (trees and small trees) per quadrat expressed as a percentage of the total in the three geographic regions and throughout Victoria. SW = south-west (n = 11), BP/SC = Bellarine Peninsula and Surf Coast (n = 31), MP = Mornington Peninsula (n = 118) and Victoria as a whole (n = 160).

cliff and Swan Island. At Portarlington, a large region of Coastal Moonah Woodland probably followed the coast south to Swan Bay and inland a few kilometres. Currently only one small remnant of mature Moonah trees (no understorey) exists on a roadside reserve at Indented Head.

On the Bellarine Peninsula surrounding Swan Bay, Weston and Moulton (1999) described several woodland communities that varied in structure and composition. Some were structurally dominated by Coast Tea-tree and were often associated with Coast Beard-heath. In these communities the understorey was usually composed of Small-leaved Clematis, Bower Spinach and Coastal Sword Sedge. In other more disturbed areas, Coast Wirilda occurred in association with Coast Beard-heath (Weston and Moulton 1999). Coastal Moonah Woodland with variable understorey composition with a few old Coast Beard-heath individuals may represent an older community state of the above mentioned vegetation associations (Weston and Moulton 1999).

Currently the main stands of Coastal Moonah Woodland on the Bellarine Peninsula occur at Swan Island, 'The Narrows' in Queenscliff, Point Lonsdale Golf Club and at 54 Acres and Saratoga Parks (both in Barwon Heads). The community occurs mainly on calcareous dunes, although a few ecotone sites are on peaty soils adjacent to watercourses and salt marshes. All characteristic species are present, with Bower Spinach abundant at all sites. The canopy may consist of Moonah, Coast Beard-heath or Coast Tea-tree or some combination of these three species. Small-flower Flax-lily *Dianella brevicaulis* occurs in the community at most locations. Large, presumably very old, individuals of Moonah are scattered in paddocks throughout the region, up to a kilometre inland. The endangered Bellarine Yellow Gum *Eucalyptus leucoxylon* subsp. *bellarinensis* occurs adjacent to calcareous dune communities on the Bellarine Peninsula (FIS 2007).

Mornington Peninsula

On the Mornington Peninsula the pre-European distribution of Coastal Moonah Woodland included most of the calcareous dune fields of the Nepean Peninsula. There are currently many small stands of Coastal Moonah Woodland on the Peninsula, totalling some 800 ha. These are scattered between Point Nepean, Cape Schanck and Tootgarook. The largest stands are

in Point Nepean National Park (> 300 ha), at Tootgarook (approximately 100 ha on private land) and some 75 ha in private ownership adjacent to the Gunnamatta Life Saving Club. All other stands are less than 50 ha (Tonkinson *et. al.* 2003). Again the dominant canopy species vary and may be Moonah, Coast Beard-heath or Coast Tea-tree or some combination of these. Partly due to the disturbed nature of existing remnants, the structure and floristic composition of the community varies. Native species that are typical disturbance colonisers include Coast Tea-tree, Seaberry Saltbush *Rhagodia candolleana* and Bower Spinach. Coast Banksia *Banksia integrifolia* often occurs as scattered individuals, mainly outside Coastal Moonah Woodland remnants, and may be part of a related plant community.

On Churchill Island, a similar vegetation type dominated by Moonah occurs on basaltic clay loam and is less than two hectares (Sutter and Downe 2000). Two degraded and unusual remnants dominated by Moonah occur on Phillip Island. One stand is on peaty soils adjacent to salt marsh and includes Coast Manna Gum *Eucalyptus viminalis* subsp. *pryoriana* and other species uncharacteristic of Coastal Moonah Woodland (Sutter and Downe 2000). The second occurrence is Coastal Moonah Woodland as it occurs on a calcareous dune system where Seaberry Saltbush and Bower Spinach dominate the understorey (Sutter and Downe 2000).

The most easterly occurrence of Coastal Moonah Woodland is at Wilsons Promontory. On the calcareous dunes of Yanakie Isthmus, Moonah is absent (Willis 1948), although we find most of the species that are characteristic of Coastal Moonah Woodland (Chesterfield 1998; FIS 2007). Pollen studies undertaken in this region reveal that over the last 6000 years the calcareous hind dune vegetation has been dominated by Drooping Sheoke woodland (Hope 1974). Coast Banksia occurred in the dune swales, and on the more exposed seaward dunes scrub dominated by Coast Tea-tree may have occurred (Hope 1974).

Discussion

This descriptive study documents the current extent and floristic variation of Coastal Moonah Woodland in Victoria. It highlights the severe decline in extent since European settlement to less than 10% of its original distribution. The community varies floristically throughout its

range depending on location in the landscape, exposure to coastal influences and disturbance history. The small size of remnants and their proximity to human activity has resulted in many degraded and weed-invaded stands. The largest remnants occur on the southern Mornington Peninsula and the Discovery Bay region in south-west Victoria.

Community floristics (composition, structure, definition)

Remnants in south-western Victoria had higher species richness, a greater proportion of native species, and generally were in better condition when compared with remnants elsewhere in the State. This could be a consequence of the different land uses surrounding the community in other regions. The south-west remnants are primarily surrounded by agriculture, whereas remnants elsewhere have more urban land use. Remnants on the southern Mornington Peninsula, Bellarine Peninsula and Surf Coast had similar species richness and a similar ratio of exotic to native species. These remnants are close to human habitation and hence increased opportunity for disturbance and weed invasion. Seaberry Saltbush, Bower Spinach and Coast Tea-tree are typical coastal disturbance colonisers. We found them in at least 65% of sites.

Some of the species, which are considered to be characteristic of this community, were not recorded in the quadrats, despite being observed in adjacent vegetation and in the local area. This detection issue highlights the need for a thorough search of the remnant and immediate surrounding landscape for characteristic species of the community, particularly in urban and highly fragmented areas. In these localities past and present disturbances may have made detection of species and indeed the identification of the community problematic. Indeed some species may have disappeared from the remnant altogether. For example, in the historical literature Drooping Sheoke is commonly reported as a co-dominant of the canopy (Crocker 1944; Gibbons and Downes 1964; Calder 1975; Head 1988). However, presently this species occurs only as scattered individuals and is not commonly reported in Coastal Moonah Woodland. Coast Spear-grass *Austrostipa flavescens* was recorded frequently in this community, although it has not been mentioned in the Action Statement as a character species (DSE 2002).

Coastal Moonah Woodland has a variable structure depending on location in the landscape, exposure to coastal influences and disturbance history. Some expressions of the community are a closed shrubland formation, while others exhibit an open-forest structure. Its understorey structure also varies; for example, an open-forest remnant may have a grassy or shrubby understorey. The results of this study display trends in good quality remnants (e.g. remnants that have low weed cover) of an extensive moss and herbaceous component in the ground layer. The Moonah *Melaleuca lanceolata* dune communities studied by Wark (1999) displayed similar structural variation. In these dune communities several species were found in all sub-communities, which varied from open scrub to open heath. These were Moonah, Coast Beard-heath, Silky Guinea-flower *Hibberta sericea*, Coast Tussock-grass *Poa poiformis*, Coast Sword-sedge and several other herbaceous species (Wark 1999).

A question of geology

This study focused on the calcareous dune systems, as the Action Statement outlines that the community has a restricted distribution due to this reliance on coastal dune limestone (DSE 2002). However, there are floristically similar vegetation types occurring on other soil types, including basalt, saline and peaty soils, shell middens and old bird rookeries, for example the similar vegetation dominated by Moonah on Churchill and Phillip Islands. This vegetation is not considered part of Coastal Moonah Woodland due to the soil difference. In addition, these vegetation types do not align with the description of the Ecological Vegetation Class of Coastal Alkaline Scrub. However, some of these communities are often ecotones or edges of Coastal Moonah Woodland and neighbouring vegetation. Some of these substrates are alkaline or the remains of substrates that were once alkaline that supported Coastal Moonah Woodland but have now been eroded away (e.g. shell middens and bird rookeries). This ecotone vegetation usually has all the characteristic species of Coastal Moonah Woodland present with a few extra uncharacteristic species as well.

Management implications

The majority of Coastal Moonah Woodland remnants have high rehabilitation potential, and community groups have shown interest in

participating in rehabilitation activities. Fencing sites to minimise human disturbance and weed control would improve the condition and resilience of remnants.

Mature remnant Moonah trees are located in parks, residential gardens, along roadsides and scattered in paddocks. These stands have good canopy cover, usually with exotic grasses (less than 300 mm high) dominating the understorey. These sites clearly no longer qualify as Coastal Moonah Woodland as they lack essential community characteristics and the grassy understorey is frequently mown or grazed. However, such sites have high revegetation potential, due to the persistence of a structural framework and lack of woody weed invasion.

In conclusion

This journey through the distribution and floristics of Coastal Moonah Woodland in Victoria hopefully has provided insights that will be useful to land managers and naturalists alike. Extant remnants are distributed in three broad geographic regions in coastal Victoria; in the south-west from Portland through to the South Australian border, on the Surf Coast from Airys Inlet through to the Bellarine Peninsula and on the Mornington Peninsula, with outliers on Phillip Island and Wilsons Promontory. Generally, remnants in the south-west of the State appear in better condition, possibly due to fewer disturbances in adjoining vegetation. The degraded nature of remaining stands and the structural variation that results from disturbance history and landscape position provide a diversity of remnants as a basis for future improvement of community condition.

Acknowledgements

The authors would like to thank Gidja Walker, Imelda Douglas, Anna Murphy, Dale Tonkinson and Steve Sinclair for field support. Extra thanks to Steve Sinclair as well as David Cheal and an anonymous referee for manuscript comments. This work is derived from various projects funded through the Port Phillip and Westernport Catchment Management Authority, the National Heritage Trust and the Victorian Department of Sustainability and Environment.

References

Bird ECF (1975) The shaping of the Nepean Peninsula Victoria, Australia. *The Victorian Naturalist* **92**, 132–141.
 Calder W (1975) Peninsula Perspectives. Vegetation on the Mornington Peninsula, Victoria. Hedges and Bell, Sponsored by National Heritage Trust of Australia (Victoria), Victorian State Government.
 Chesterfield EA (1998) The vegetation of Wilson's Promontory National Park. *The Victorian Naturalist* **115**, 337–342.

Crocker RL (1944) Soil and vegetation relationships in the lower south-east of South Australia - A study in ecology. *Transactions of the Royal Society of South Australia* **68**, 144–172.
 DSE (2002) Flora and Fauna Guarantee Action Statement #141 Coastal Moonah Woodland. Department of Natural Resources and Environment, East Melbourne.
 DSE (2004) EVC/Bioregion Benchmark for vegetation quality assessment. 1 – Bridgewater Bioregion. 2 – Gippsland Plain Bioregion, 3 – Otway Plain Bioregion. EVC 858: Coastal Alkaline Scrub (syn. Clarendine Dune Woodland). Department of Sustainability and Environment, Melbourne.
 FIS (2007) Victorian Flora Information System. Version 2007. Department of Sustainability and Environment, Melbourne.
 Gibbons FR and Downes RG (1964) A study of the land in south-western Victoria. (Soil Conservation Authority: Victoria)
 Head L (1988) Holocene vegetation, fire and environmental history of the Discovery Bay region, south-western Victoria. *Australian Journal of Ecology* **13**, 21–49.
 Hope GS (1974) The vegetation history from 6000 BP to present of Wilson's Promontory, Victoria, Australia. *New Phytologist* **73**, 1035–1053.
 JCVRFASC (2000) West Victoria Comprehensive Regional Assessment. Biodiversity Assessment. Joint Commonwealth and Victorian Regional Forest Agreement Steering Committee, Canberra.
 McGregor G and Johnstone P (1987) Point Nepean: A Proposed National Park Draft Plan of Management. A project funded by the Commonwealth/State Bicentennial Program. Department of Conservation, Forests and Lands, Victoria.
 Oates A and Taranto M (2001) Vegetation mapping of the Port Phillip and Westernport Region. Arthur Rylah Institute for Environmental Research, Department of Natural Resources and Environment, Melbourne.
 Ough K (2001). Regeneration of wet forest flora a decade after clear-felling or wildfire – is there a difference? *Australian Journal of Botany* **49**, 645–664.
 SAC (1998) Final recommendation on a nomination for listing: Coastal Moonah (*Melaleuca lanceolata* subsp. *lanceolata*) Woodland Community (Nomination 460). Scientific Advisory Committee, Flora and Fauna Guarantee. Department of Natural Resources and Environment, Victoria.
 Specht RL and Specht A (1999) *Australian Plant Communities: Dynamics of structure, growth and biodiversity*. (Oxford University Press: Melbourne)
 Sutter G and Downe J (2000) Vegetation Community Survey and Mapping of the Phillip Island Nature Park. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Melbourne. Unpublished report
 Tonkinson D, Taranto M and Kefford E (2003) Report on mapping and condition assessment of remnant native vegetation for the Mornington Peninsula Shire. Arthur Rylah Institute for Environmental Research, Department of Natural Resources and Environment, Melbourne.
 Walsh NG and Stajsic V (2007) *A census of the vascular plants of Victoria*. 8th ed. (National Herbarium of Victoria, Royal Botanic Gardens: South Yarra)
 Wark MC (1999) Regeneration of *Melaleuca lanceolata* Otto. and *Melaleuca squarrosa* Donn ex Sm. Communities of the coast and river valleys in the north-eastern Otway ranges 1–10 years after the wildfire of February 1983. *Proceedings of the Royal Society of Victoria* **111**, 173–213.
 Weston M and Moulton P (1999) Guidelines for the protection of coastal woodlands. Protection of the natural values of national estate-listed coastal woodlands in Victoria: a report to the Australian Heritage Commission. (Victorian National Parks Association: Melbourne) (Unpublished report)
 Willis JH (1948) On the nature and distribution of 'Moonah' (*Melaleuca pubescens* Schauer). *The Victorian Naturalist* **65**, 76–84.

Received 25 September 2008; accepted 5 February 2009